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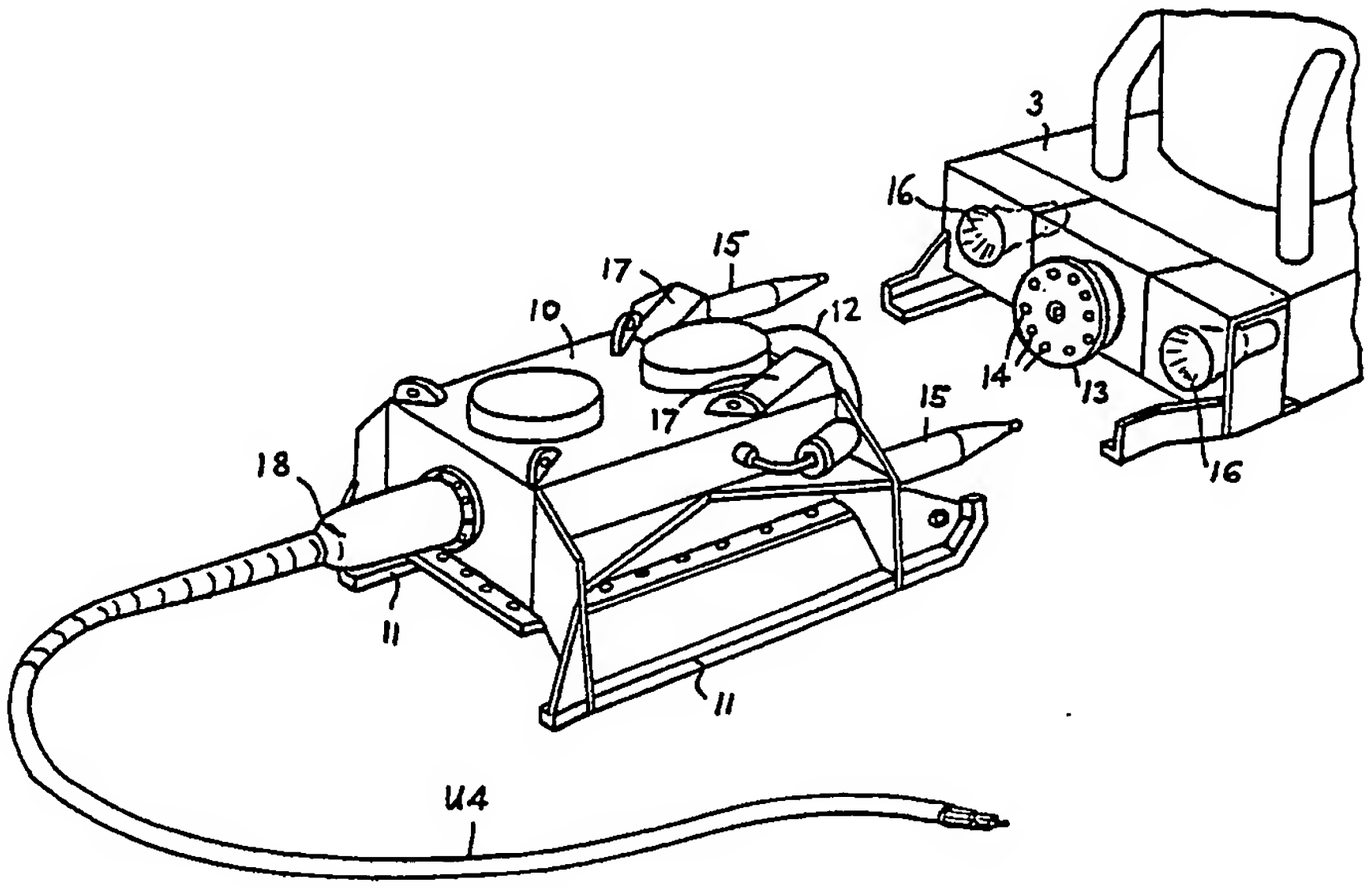

(57) Abstract

A system for the control of subsea extraction of a liquid or gaseous hydrocarbon product from a well head on the sea bed in which the product is extracted under the control of valve systems contained in a christmas tree (3) located over and secured to the well head and is then fed via a pipeline to a remote terminal. The christmas tree is controlled and monitored by a control module package (10) which forms the end termination to an umbilical U4 supplying power from and transmitting signals to and from said remote terminal. The control module package (10) is physically connected to the christmas tree (3) underwater by engaging the complementary end terminations (12) and (13) and forms the sole power and signal path connection between the christmas tree and the remote terminal. Guide means (15, 16) and optical or acoustic sensors (17) may be provided to assist in aligning the terminations (12) and (13) during their interconnection.

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SUBSEA SYSTEMS AND DEVICES

The present invention relates to subsea systems and devices and particularly to such systems and devices as are employed for the control and monitoring of off-shore subsea production and distribution of hydrocarbon products in the oil and gas industry.

It will be understood that references to the "sea" include lakes and other areas of water besides the sea and oceans proper.

Hydrocarbon products, specifically oil and gas, are currently often obtained from deposits beneath the sea bed and are extracted by forming a production bore or well downwardly from the sea bed into the reservoir deposits and extracting the products through the well head. The series of operations which initially have to be performed in order to extract the hydrocarbon products from a reservoir deposit are known as drilling and completion operations. These operations are not restricted to wells formed by drilling from a fixed structure. Wells may also be formed by drilling through a target area on the sea bed at a position remote from any fixed or floating surface-located process control facility.

Such operations often have to be carried out at considerable depths below the sea surface, for example several hundred metres and are extremely complex, time-consuming and expensive operations to perform. These drilling and completion operations also involve numerous complex and difficult steps, not the least of which is the deployment and connection of a remotely controlled local control and performance monitoring system at the

well head for use when the well is to be brought into production. Additionally there are numerous hazards and difficulties associated with the connection of power supplies, and control and monitoring signal paths to the local control system at the site of the well. The present invention is more particularly concerned with problems associated with these latter aspects of the subsea extraction of hydrocarbon products from beneath the sea bed.

Currently, the type of control and monitoring systems employed to control and monitor the functions of a subsea well make use of hydraulically operated function control valves and hydraulic, electrical or electronic monitoring devices contained within a package mounted on a structure known as a subsea christmas tree which normally is vertically lowered into position over the well head tubing and secured thereto. The control and monitoring of the christmas tree functions are undertaken by the control module package which is secured to the christmas tree as a modular system and control power is supplied and directed to the christmas tree via the control module package from a remote terminal. This remote terminal may be on the land but more often takes the form of a fixed or floating purpose built process control platform anchored to the sea bed and to which the hydrocarbon product extracted from the well under the control of the christmas tree is delivered for processing and/or distribution and from which processed water or gas is re-injected back into the reservoir structure via the well, e.g. by means of

pipelines or other form of distribution. A terminal is frequently situated a considerable distance, for example several kilometres, from the location of the christmas tree and apart from the pipeline extending between the two for the transportation of the various liquids and/or gases, it is necessary to provide connections for the supply of power generally of a hydraulic and/or electrical nature to the christmas tree control module package and also for the transmission of control signals and exchange of information between the terminal and the subsea system. Such connections are currently made by means of cables known as umbilicals constructed to withstand the subsea conditions and to convey the hydraulic and/or electrical power and signals necessary for the operation and monitoring of the system.

The subsea christmas tree is usually lowered into position from a semi-submersible drilling rig, which may have also been employed to drill the well. By reason of the considerable difficulties in deployment which would be entailed, it is not generally possible to make connections between the pipeline, umbilicals and the christmas tree and/or the control module package on the surface before the pipeline, christmas tree and/or umbilicals are lowered into the sea and therefore a number of these connections normally have to be made under water, which is in turn an intricate , expensive, complex and time-consuming operation. Moreover, since the control module package is normally located on and to one side of the christmas tree its weight has to be

balanced by a counterweight located at the opposite side of the christmas tree in order that the latter is maintained stable and upright during its vertical deployment from the rig and connection to the well head tubing. This in turn can undesirably increase both the weight and bulk of the christmas tree, which is to be lowered and manoeuvred into position over the well head.

It is an object of the present invention to provide means for overcoming or reducing some of the disadvantages enumerated above in connection with the disposition of the control module package and the making of the connections both to the christmas tree and/or to the control module package.

According to the present invention the control module package for a subsea process control device or system, such as a christmas tree, is constructed so as to form an end termination to a submarine umbilical which is deployed on the sea bed for horizontal pull-in and connection to the subsea system. According to a preferred form of the invention this single umbilical forms the only control and monitoring interconnection which is necessary between the remote terminal on the one hand and the subsea process control device or system or christmas tree on the other hand.

From one aspect the invention provides a submarine umbilical having an end termination in the form of a control module package for controlling a subsea process control device or system or christmas tree and forming the sole power and signal path connection between said system or christmas tree and a remote terminal when said

end termination is connected to said system or christmas tree.

From another aspect the invention provides a control module package for a subsea christmas tree provided with connection means for connection to said christmas tree underwater to enable said control module to perform control and monitor functions on the christmas tree, wherein said control module is designed to form an end termination to an umbilical by means of which power may be supplied to said christmas tree via said control module and control signals may also be applied to and monitoring data derived from said control module and/or said christmas tree.

From yet another aspect the invention consists of a system for the control of subsea extraction or distribution of a liquid and/or gaseous product from under the sea bed wherein the product is directed or extracted under the control of a process control system located on the sea bed and is fed to a remote terminal and having a control module package physically connectable to the process control system on the sea bed, said control module package being supplied and controlled from the remote terminal and acting to control and monitor the functioning of the process control system, wherein said control module package forms the end termination of a line extending between said remote terminal and said process control system and line serving both to supply power and for the transmission of information and control signals, and said control module package forming the sole power and signal transmitting component to be

physically connected underwater to said process control system.

From yet a further aspect the invention provides a system for the control of subsea extraction of a liquid and/or gaseous hydrocarbon product from a well head on the sea bed wherein the product is extracted under the control of valve systems contained in a christmas tree located over and secured to the well head and is fed via a pipeline to a remote terminal and wherein the christmas tree is controlled and monitored by a control module package which forms the end termination to an umbilical for supplying power from and transmitting signals to and from said remote terminal, said control module package being physically connected to said christmas tree underwater and forming its sole power and signal path connection to said remote terminal. The christmas tree may be one of a multiple group of subsea christmas trees and several or all of said christmas trees may have such a control module package connected to it.

According to current practice, a subsea christmas tree per se requires a supply of hydraulic power for the operation and monitoring of its hydraulically operated valves whilst the control module generally requires a supply of electrical power as well as the provision of signal transmitting conductors which may be either electrical conductors or optical fibres. In such a case the arrangement of the present invention would make use of a composite umbilical containing both hydraulic power supply lines and the necessary electrical power and signal conductors or possibly optical fibre signal

conductors.

The end termination may comprise an oil filled pressure compensated container in which is located hydraulic control valves as well as electrical and/or electronic devices and control systems for controlling and monitoring the operations being performed by the hydraulic mechanisms of the christmas tree or other subsea process control modules. The container is mounted on runners or a sled device in order to facilitate its movement over the sea bed and it can be made so that it is both self-propelled and remotely controlled, if so desired.

As is known in the art, guide means are provided for the course and fine alignment of the make up of underwater end terminations with respect to the christmas tree or other subsea process control module in order to facilitate proper connection thereto as well as means for clamping the termination comprising the control module package to the christmas tree or other subsea process control module once it has been guided and located into its correct position.

Means may also be provided for manual or robotic disconnection of the umbilical from the end termination comprising the control module package.

If desired optical or acoustic means such as television cameras or acoustic sensors may also be provided for assisting in lining the end termination with its connection to the christmas tree.

It will be appreciated that by means of the arrangement according to the present invention all of the

electrical and hydraulic connections between the umbilical and the control module may be made on the surface when the control module package is being connected as the end termination to the umbilical and hence the only connection which has to be made underwater is that of the control module package to the christmas tree or other subsea process control system. Since the power connection between the control module package and the christmas tree or other subsea production control system need often only be of a hydraulic nature, as the valves in the christmas tree or other control system are usually hydraulically operated, it is possible totally to eliminate any underwater connections for the electrical power and electrical or optical fibre signal lines during the installation of the equipment on the sea bed. Moreover, since in the case of a subsea process control system christmas tree the control module package for the christmas tree now forms the end termination of the umbilical and no longer forms a structure attached to the christmas tree, the out-of-balance weight of this control module is removed from the christmas tree during deployment and hence the counterweight can be dispensed with. This not only considerably lightens the weight of the christmas tree making it more easy to handle and manipulate into its correct position over the well head, but its reduced weight greatly facilitates its transfer between a supply vessel and the rig from which it is lowered onto the well head.

The invention will now be further described, by way

of example, with reference to the accompanying drawings, in which:-

Figure 1 illustrates in simple diagrammatic form an installation for extracting oil or gas from a well on the sea bed and for feeding its product to a remote terminal, according to current practice,

Figure 2 is a diagrammatic perspective view of one embodiment of end termination for an umbilical, according to the present invention,

Figure 3 is a diagrammatic sectional view through one form of hydraulic tree connection which may be employed in the present invention,

Figures 4a and 4b illustrate diagrammatically two arrangements according to the invention for multiple christmas trees contained on a template; and

Figure 5 is a diagrammatic view of another arrangement according to the invention.

Referring to the drawings, Figure 1 shows diagrammatically a known type of oil (or gas) drilling and collection installation for extracting oil from below the sea. A semi-submersible drilling rig 1, anchored by cables 1a and which has been used to drill a production well 2 is also employed to position and install a christmas tree 3 over the top of the well, when it is desired to extract the oil from the well. The well head may be several hundred metres below sea level. The christmas tree 3 may be employed to control the flow of oil from the well or to inject processed water into the well in accordance with known techniques and comprises a hydraulically operated control valve

arrangement. This christmas tree is itself controlled and monitored by means of a control module package 4 which is mounted to one side of the christmas tree and which has to be counterbalanced by a weight 5 on the other side in order to ensure that the christmas tree is maintained stable and upright for lowering from the rig 1 and positioning over the well head. The oil from the well 2 is delivered via a pipeline indicated at 6 to a remote terminal 7 in the form of a fixed or floating platform which is anchored to the sea bed and which is located at a distance, e.g. several kilometres from the well head.

In order to supply power to the christmas tree 3 and to the control module package 4 and to control this equipment from the terminal 7, two armoured cables or umbilicals U1 and U2 are employed. The umbilical U1 serves to supply hydraulic power from the terminal 7 to provide control power for the operation of the christmas tree 3 via the control module package 4, whilst the umbilical U2 serves to supply electrical power to the control module package 4 and also for the transmission of monitoring data and control signals to and from the terminal 7. The connections T1, T2, between the umbilicals and the christmas tree and control module can only be made under water once the christmas tree has been located in position, for the reasons given earlier, and this is a complex, time consuming and expensive operation. Once the christmas tree has been located in position, connected to the terminal and tested, the rig 1 is removed from the site.

The present invention provides an arrangement which, in practical terms,allows the umbilical U2 to be omitted and which also removes the control module 4, and hence the counter-balances weight 5, from the christmas tree structure. To this end, according to the invention, the control module for the christmas tree is constructed so as to form the end termination of a submarine umbilical which is horizontally deployed on the sea bed for connection to the christmas tree.

Figure 2 illustrates one embodiment of the invention showing a control module package 10 forming an end termination to an umbilical U4 which is arranged to supply both hydraulic power, and electrical power to the control module and which may also include electrical and/or optical fibre signal conductors for the transmission of control information and data between the control module and the terminal platform. The control module package 10 is mounted on runners 11 for easy travel over the sea bed and it may be deployed manually, remotely or by self-propulusion. Only hydraulic power is required by the christmas tree 3 and this is fed in directly through a termination 12 on the control module 10 which is arranged to mate with a complementary termination 13 on the christmas tree. The termination comprises a plurality of hydraulic connections 14 and the control module is guided into its correct location for accurate aligned connection of the terminations 12,13 by means of guide probes 15 which engage guide sockets 16 to either side of the termination 13 on the christmas tree. Optical and/or acoustic sensors 17 may be provided on the control module 10 initially to assist in carrying out the connecting operation but further to monitor process function status with the aid of local self-contained sensors mounted on the christmas tree. Once the connection has been made it may be secured by means of a clamping device of any suitable kind. Since

the connection 18 made between the umbilical U4 and the control module 10 can be made on the surface before the control module is lowered to the sea bed, the only connection which has to be made on the sea bed is that of the control module 10 to the christmas tree.

Although the arrangement has been described for a christmas tree which is solely hydraulically operated, it would readily be possible to feed electrical power additionally or alternatively to the christmas tree from the control module, if this was considered necessary for operation or monitoring of the christmas tree functions.

Figure 3 illustrates one form of hydraulic tree connection which may be used in carrying out the present invention. The connector comprises two complementary generally cylindrical parts 21,22 and an annular clamping member 23. The part 21 is associated with the control module and comprises a body 24 having a recessed end cavity 25 within which are disposed an array of hydraulic connectors 26 about a central axially disposed and axially movable key or plunger 27. The complementary part 22 carried by the christmas tree comprises a body 28 whose forward end 29 is shaped to enter the end cavity 25 in the part 21 and carries complementary hydraulic connectors 30 disposed so as to mate and interconnect with the connectors 26 when the two parts of the coupling are engaged. These connectors 30 are disposed about an axial locating bore or passage 31 which can receive the leading end of the key or plunger 27. The open end of the cavity 25 is protected during deployment by a protective shield or plate, indicated in dashed lines at 32, until the connection is to be made. At that time, the connector part 21 is aligned in close proximity with the connector part 22 and the key or plunger

27 is moved outwardly under hydraulic or electrical control so as to push off the protective shield 32 which falls away from the connector parts. The part 21 is now moved towards the part 22 so that the end of the plunger or key 27 enters the axial bore 31 and the two complementary portions 26,30 of the hydraulic connectors engage so as to complete the connection. The clamp means 23, which may take any of various known forms, is now positioned around the parts 21 and 22 to hold the hydraulic connection secure.

Figure 4a illustrate an arrangement in which up to eight christmas trees C1 to C8 are capable of being mounted on a template T1. Each christmas tree is fed by an umbilical U terminating in a control module CM serving as a process control and monitoring unit and forming the sole power and signal path connection between each christmas tree and a remote terminal. The process input/output flow line from the arrangement is shown at F and is connected to the manifold piping system carried by the template via a hydraulic connection H.

Figure 4b shows a modification of the arrangement according to Figure 4a in which only two umbilicals U5 and U6 extend between the remote terminal and up to eight christmas trees C1 to C8 contained on the template T1. Each umbilical terminates in a control module CM1 or CM2. The control module CM1 serves as a process control and monitoring unit for the christmas trees C1 to C4 and the control unit CM2 serves as process control and monitoring unit for the christmas trees C5 to C8.

Figure 5 illustrates diagrammatically an oil or gas distribution arrangement according to the invention

in which control modules CM3 and CM4 are respectively connected to product distribution control valves V1 and V2 located in product pipelines P1, P2 extending between a remote terminal 40 and a further distribution or processing site, for example on shore. Control module CM3 which monitors and controls the distribution control valve V1 forms the end termination of umbilical U7 connected to the remote terminal 40, whilst control module CM4 forms the end termination of umbilical U8 which is connected to a second remote terminal (not shown). Each control module is supplied with power over its umbilical for the operation of the associated valve. The umbilical also supplies electrical power to the control module package and serves as a two way signal transmission path between the module and the remote terminal connected at the other end of the umbilical.

It will be apparent that various modifications may be made to the embodiments described without departing from the scope of the invention.

CLAIMS

1. A subsea system for the control of subsea extraction or distribution of a liquid and/or gaseous product from under the sea bed wherein the product is directed or extracted under the control of a process control means located on the sea bed and is fed to a remote terminal and having a control module package physically connectable to the process control means on the sea bed, said control module package being supplied and controlled from the remote terminal and acting to control and monitor the functioning of the process control means, wherein said control module package forms the end termination of a line extending between said remote terminal and said process control means, said line serving both to supply power and for the transmission of information and control signals, and said control module package forming the sole power and signal transmitting component to be physically connected underwater to said process control means.

2. A system as claimed in claim 1, wherein said process control means is a process control system such as a christmas tree.

3. A system as claimed in claim 1, wherein said process control means is a product distribution control valve.

4. A subsea system for the control of subsea extraction of a liquid or gaseous hydrocarbon product from a well head on the sea bed wherein the product is extracted under the control of valve systems contained in a christmas tree located over and secured to the well head and is fed via a pipeline to a remote terminal, the

christmas tree being controlled and monitored by a control module package, wherein said control module package forms the end termination to an umbilical supplying power from and transmitting signals to and from said remote terminal and said control module package is physically connected to said christmas tree underwater and forms the sole power and signal path connection between said christmas tree and said remote terminal.

5. A control module package for a subsea process control means,wherein said control module package is constructed so as to form an end termination to a submarine umbilical which is deployed on the sea bed for horizontal pull-in and connection to the subsea system.

6. A control module package for a subsea christmas tree provided with connection means for connection to said christmas tree underwater to enable said ccntrol module package to perform control and monitor functions on the christmas tree, wherein said control module package forms an end termination to an umbilical for physical connection underwater to said christmas tree whereby power may be supplied to said christmas tree via said control module package and control signals may also be applied to and monitoring data derived from said control module package and/or said christmas tree.

7. A control module package as claimed in claim 5 or 6, wherein said umbilical forms the only control and mcnitoring interconnection which is necessary between a

remote terminal on the one hand and the subsea process control means or christmas tree on the other hand.

8. A submarine umbilical having an end termination in the form of a control module package for controlling a subsea process control means, such as a christmas tree or distribution control valve, said control module package forming the sole power and signal path connection between said process control means and a remote terminal when said end termination is physically connected underwater to said process control means.

9. A subsea system or part thereof as claimed in any preceding claim, wherein said end termination control module package comprises an oil filled pressure compensated container in which is located hydraulic control valves as well as electrical and/or electronic devices and control systems for controlling and monitoring the operations being performed by the hydraulic mechanisms of a christmas tree or other subsea process control means.

10. A subsea system or part thereof as claimed in claim 9, wherein said container is mounted on runners or a sled device in order to facilitate its movement over the sea bed.

11. A subsea system or part thereof as claimed in claim 9 or 10, wherein said container is self-propelled and/or remote controlled.

12. A subsea system or part thereof as claimed in any preceding claim, wherein guide means are provided for the alignment of the make-up of underwater end terminations of the control module package with respect to the christmas tree or other subsea process control means in order to facilitate proper connection thereto.

13. A subsea system or part thereof as claimed in claim 12, wherein optical or acoustic means are provided for assisting in lining up said end terminations.

14. A subsea system or part thereof as claimed in any preceding claim, including means for clamping the end termination comprising the control module package to the christmas tree or other subsea process control means once it has been guided and located into its correct position.

15. A subsea system or part thereof as claimed in any preceding claim, wherein said line or umbilical comprises a composite umbilical containing hydraulic power supply lines as well as electrical conductors and/or optical fibre conductors.

16. A subsea system or part thereof as claimed in any preceding claim, wherein the only underwater connection which has to be made between said end termination provided by said control module package and said process control means, such as a christmas tree, is a hydraulic connection.

17. A subsea system as claimed in claim 2 or 4, or any subsequent claim as dependent on claim 2 or 4, comprising a plurality of christmas trees arranged as a group, each of said christmas trees being fed by a line or umbilical terminating in a said control module package forming the sole power and signal path connection between that christmas tree and a remote terminal.

18. A subsea system as claimed in claim 2 or 4, or any subsequent claim as dependent on claim 2 or 4, comprising a plurality of groups of christmas trees,

each group of christmas trees being controlled by a single control module package forming the end termination of a line or umbilical which is the sole power and signal path connection between that group of christmas trees and a remote terminal.

19. A subsea system as claimed in claim 3 or any subsequent claim as dependent on claim 3, comprising an oil or gas distribution arrangement including a plurality of product distribution control valves for controlling the distribution of said oil or gas, wherein a said control module package is connected to each said distribution control valve for monitoring and controlling said valve, and said line or umbilical connected to each said control module package is connected to a remote terminal.

20. Subsea systems substantially as hereinbefore described with reference to Figures 2 and 3, or Figure 4a, or Figure 4b or Figure 5 of the accompanying drawings.

21. A control module package for a subsea system substantially as hereinbefore described with reference to any of Figures 2 to 5 of the accompanying drawings.

22. A submarine umbilical having an end termination in the form of a control module package substantially as hereinbefore described with reference to any of Figures 2 to 5 of the accompanying drawings.

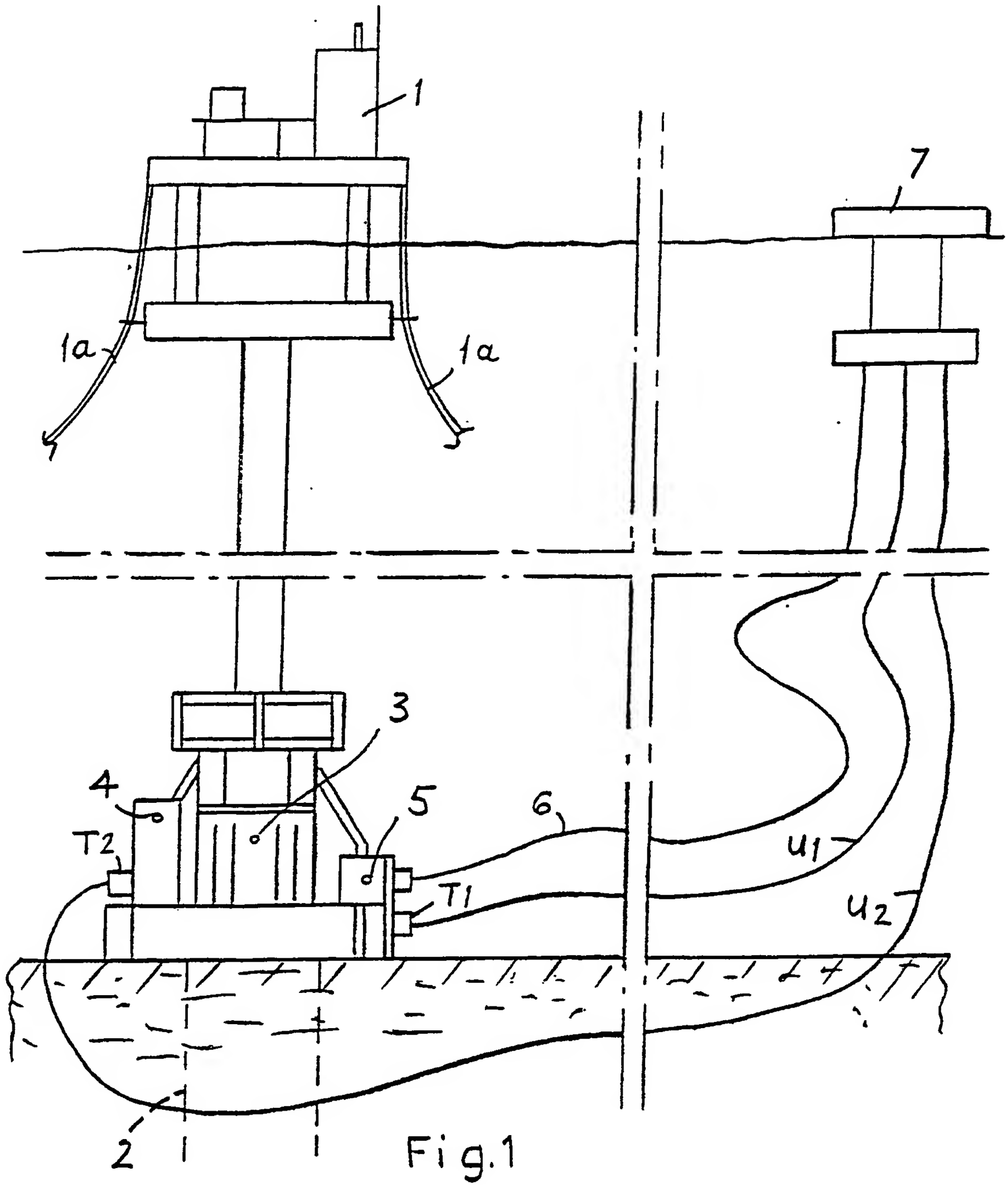


Fig.1

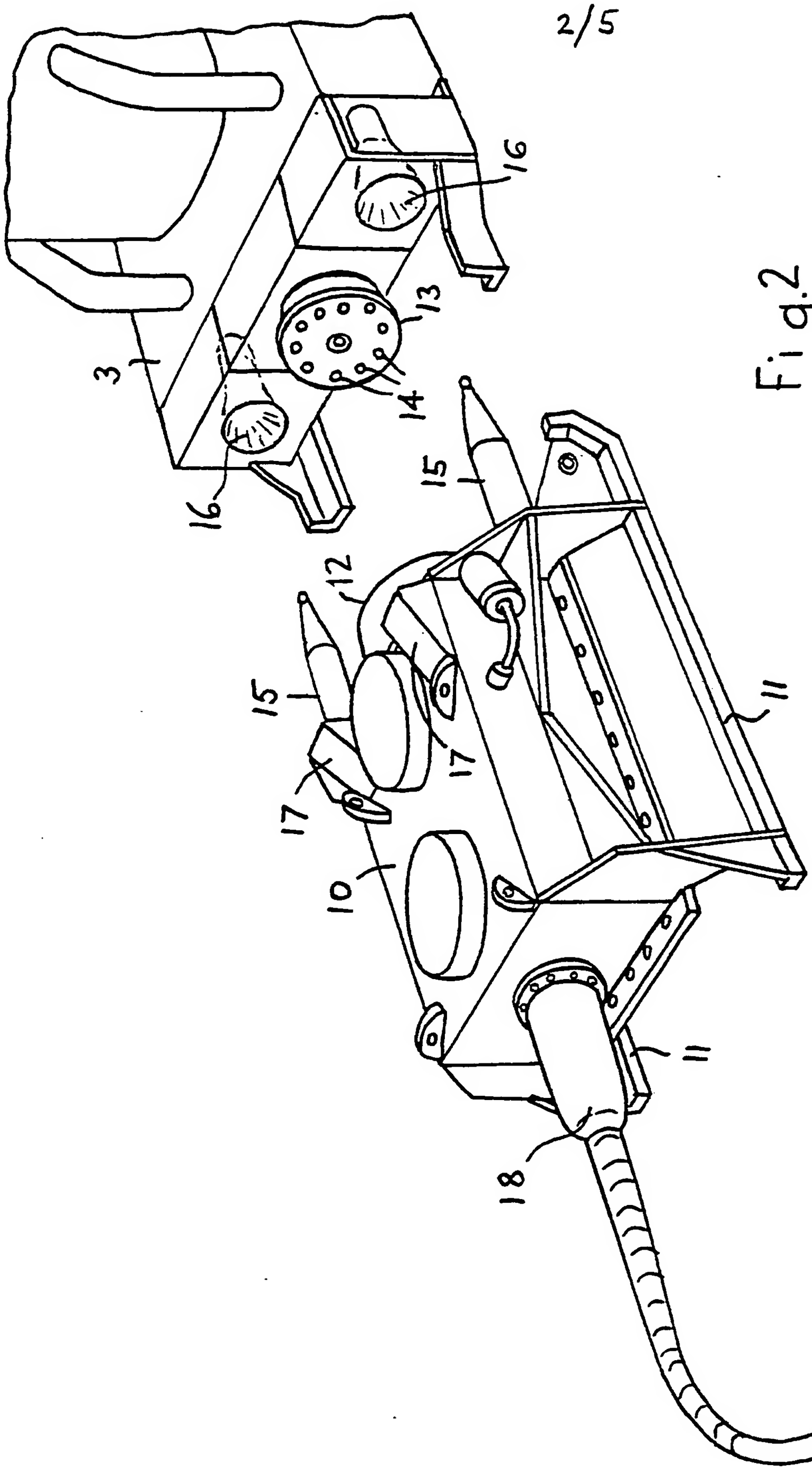


Fig.2

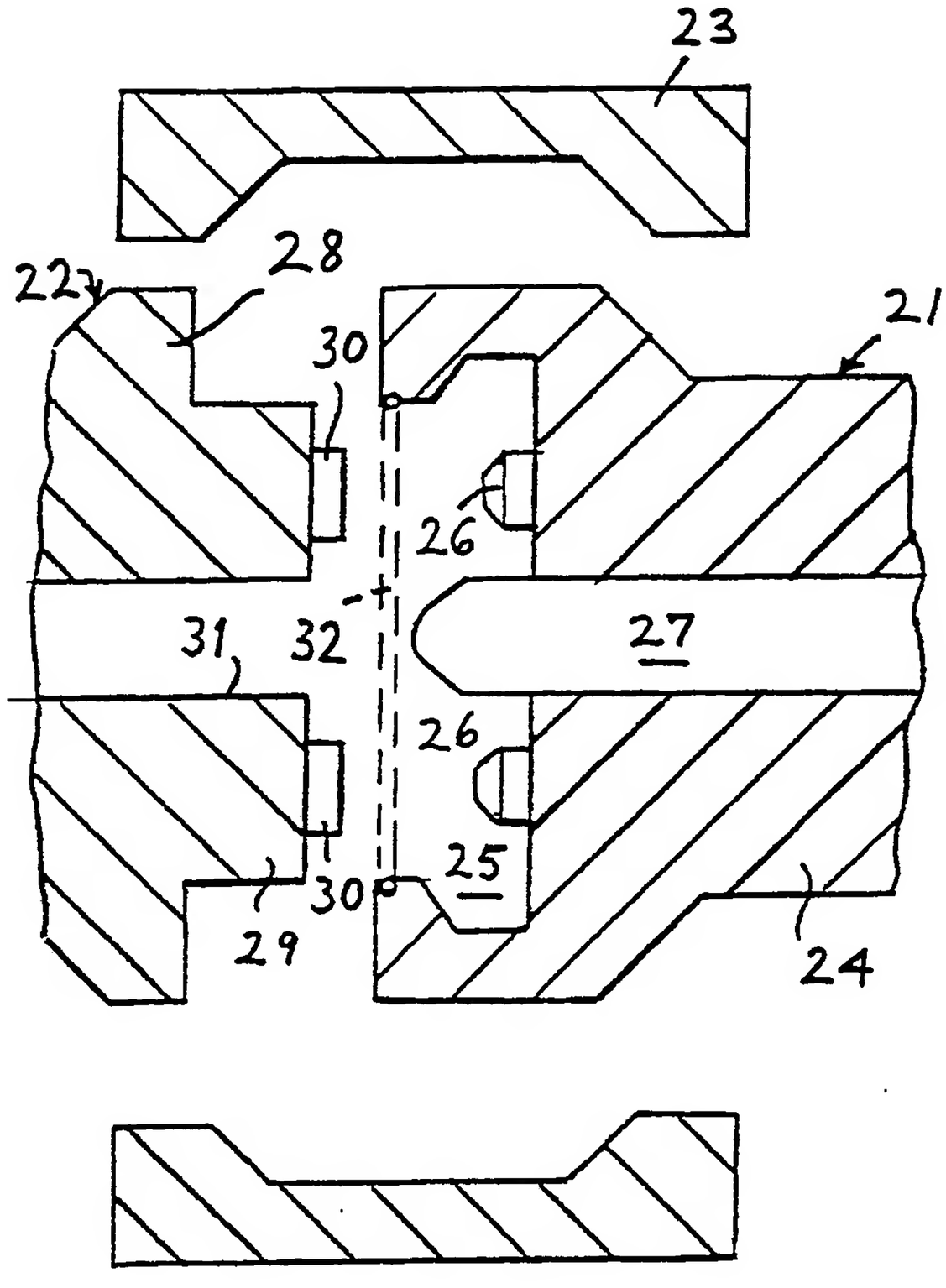
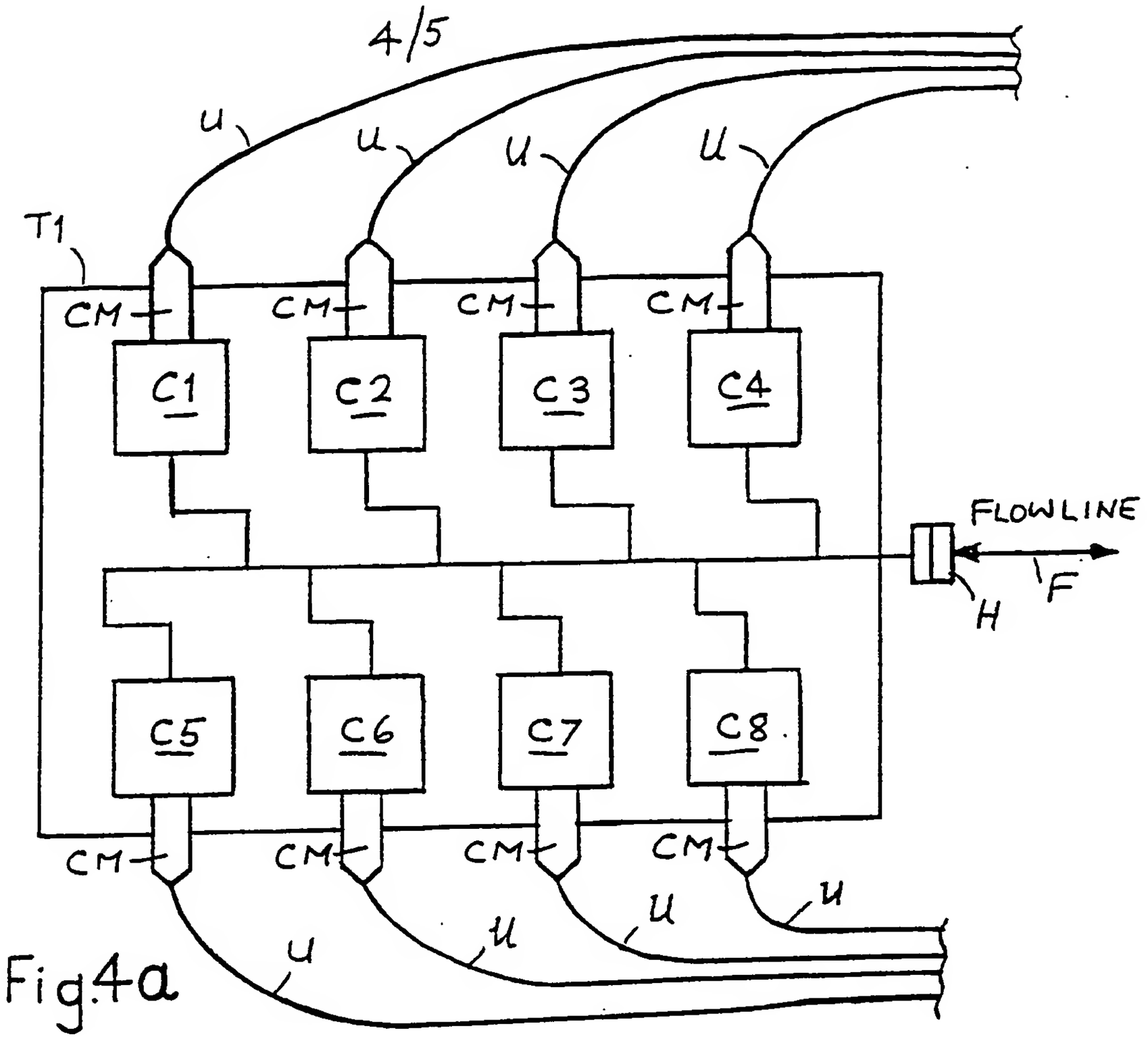


Fig.3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U
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U
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T1
CM
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CM
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C1
C2
C3
C4
FLOWLINE
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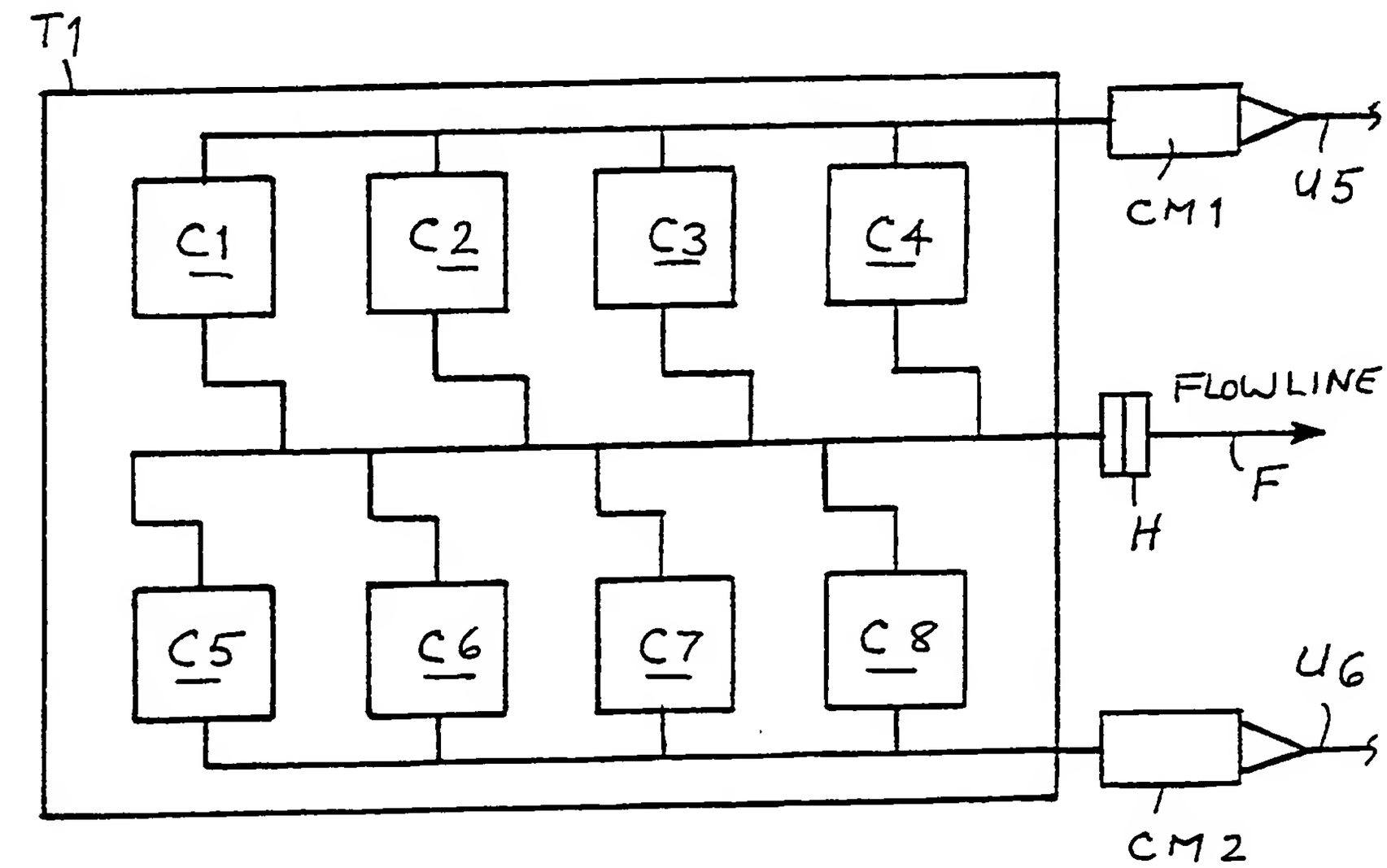
Fig.4a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C8
U6
CM2

Fig.4b

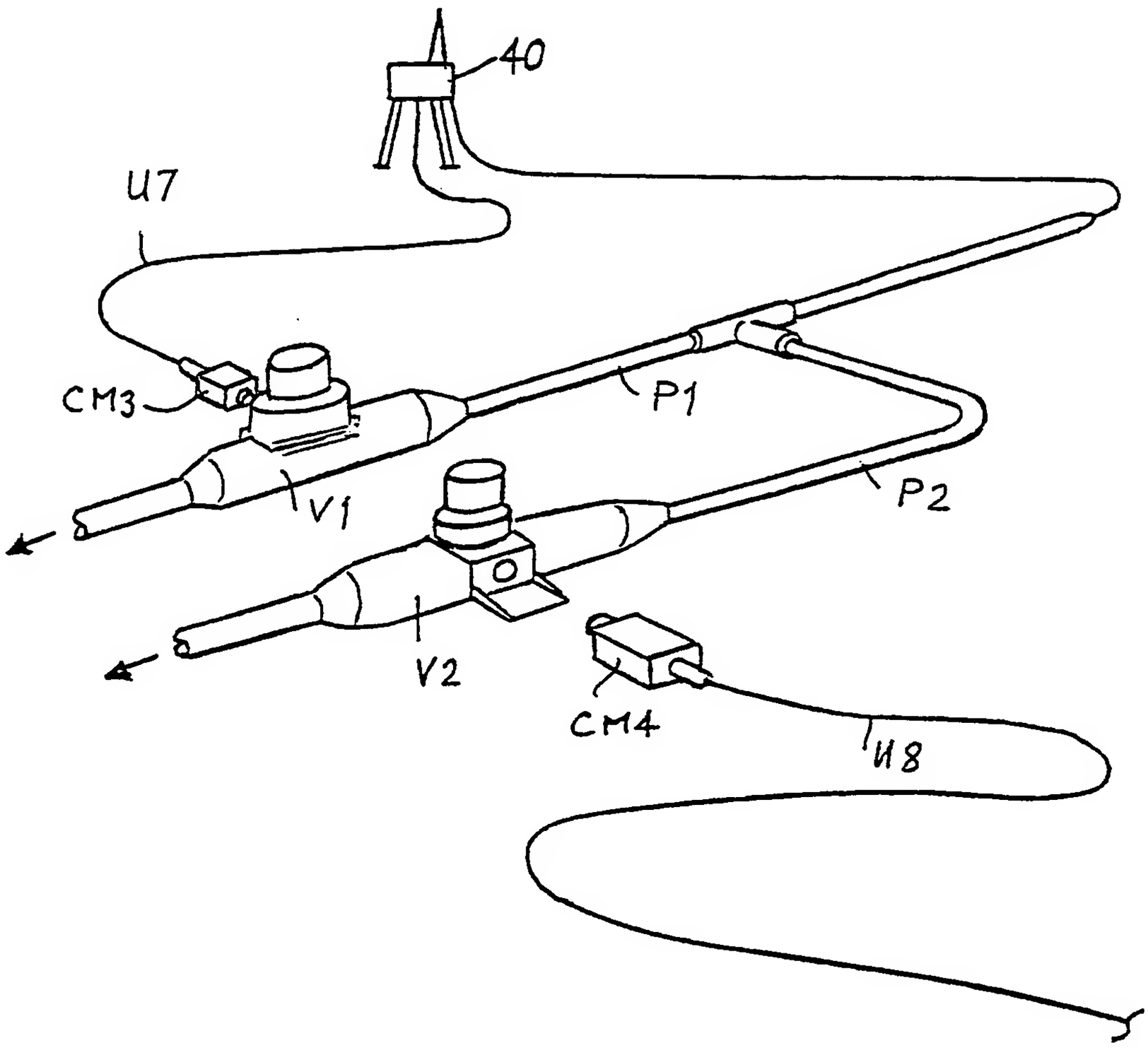

Fig.5

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 87/00783

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: E 21 B 33/038

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	E 21 B; B 63 C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	The Oil and Gas Journal, vol. 73, no. 44, 3 November 1975 (Pennwell Publ., Tulsa, Oklahoma, USA), B.C. Andrews et al., "Unit connects subsea line, buoy", pages 88-92, see the whole document --	1,4,5,6,8
A	US, A, 3635184 (LIAUTAUD) 18 January 1972, see abstract; claim 1 --	1,4-6,8
A	US, A, 3894560 (B.F. BAUGH) 15 July 1975, see column 3, lines 11-37 --	1,4-6,8
A	US, A, 4328826 (H.A. BAUGH) 11 May 1982, see abstract; claim 1 --	1,4-6,8
A	US, A, 2990851 (JACKSON et al.) 4 July 1961, see claim 1 --	1,4-6,8
A	US, A, 3640299 (NELSON) 8 February 1972, see abstract; claim 1 ------	1,4-6,8

* Special categories of cited documents: [10]

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
19th January 1988	19 FEB 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8700783 SA 19316

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 05/02/88
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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